DOE-Marin
Integrating GridAgents into SmartGrid Applications #56424
Phase 1-2 Review and Phase 3 Direction

David Cohen – Infotility CEO/PI
Jim McCray – Infotility COO/PM
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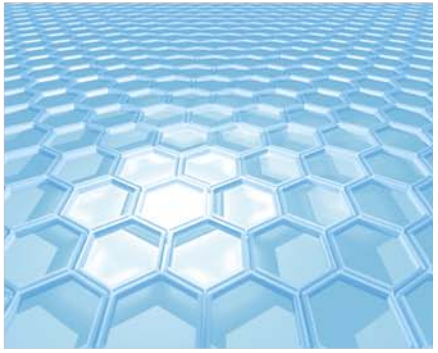

DOE – PG&E/Marin Renewables Management Project

- Funding: US Department of Energy –Electric Delivery and Energy Reliability – Smart Grid R&D Program
  - Three year – three phase project schedule and scope with $1.6 Million budget for 2008-2010.
  - Collaboration and in-kind cost share with Marin County Office of Sustainability and other Departments
  - Collaboration with ECN – Netherlands for EU Project Integral – Groningen field test and technology transfer.
  - Collaboration with PG&E and CAISO
  - Participation by vendors including Power Standards, Coulomb Technologies, and Opto22.

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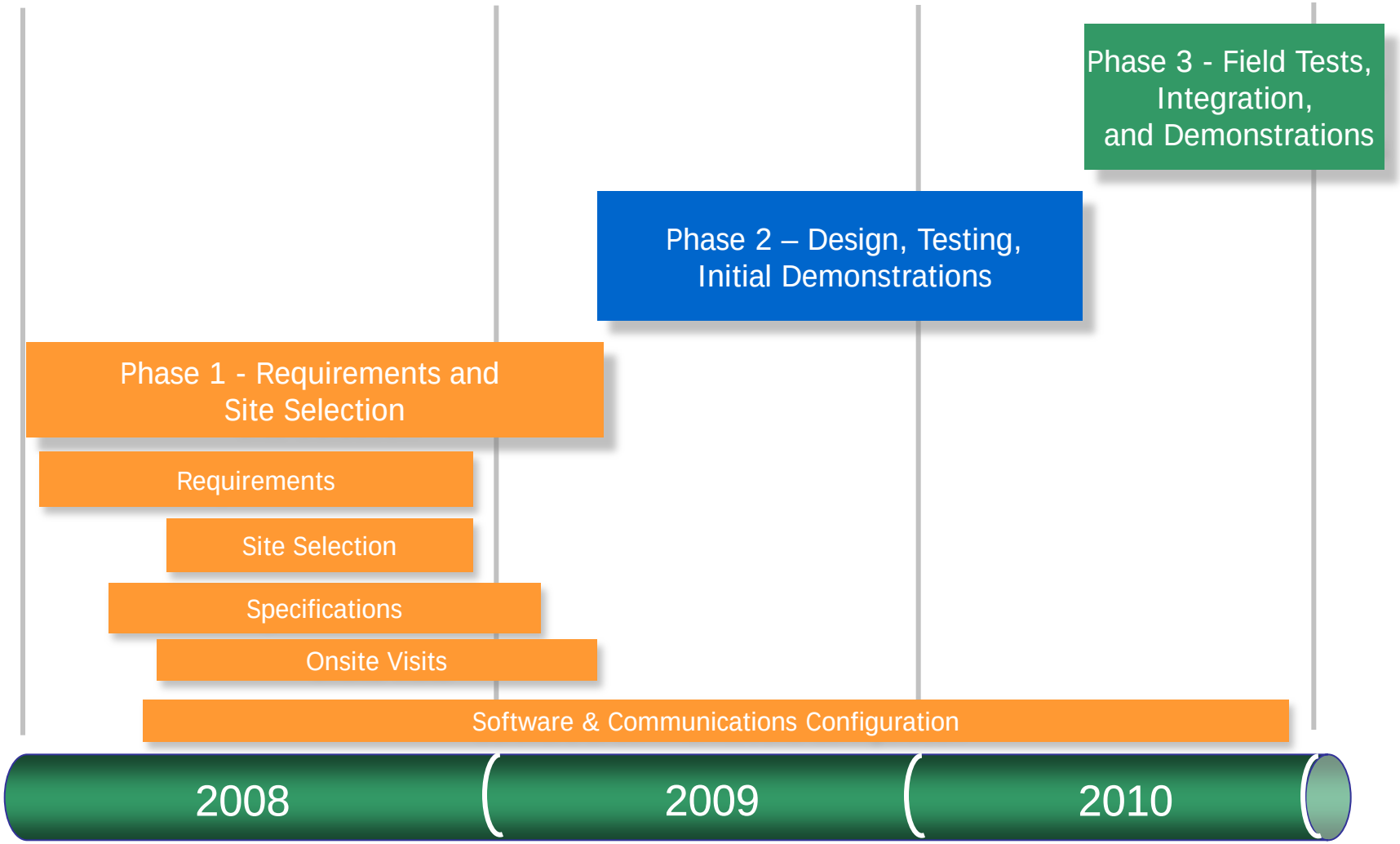
Project Objectives

- Field testing Infotility's GridAgents software on MicroGrid applications with high penetration of renewables
- Developing control strategies for optimizing the use of distributed renewables such as PV and wind, with demand response, EV charging, and storage for MicroGrids and communities (feeder level, LMP)
- Configuring GridAgents software to meet requirements of local community and utility distribution engineering decision support and network operations.
- Comparing European and US techniques for management of MicroGrids using agent technologies
- Provide a migration path to more embedded and standards based distribution network intelligence.

DOE – Marin Project Tasks and Schedule



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Phase 1 2008 Accomplishments

- Project Kickoff Meeting in Marin
- PV integration and communications specifications for Marin.
- Stakeholder meetings with Marin County, Presidio School of Management Team, CAISO, PG&E Distribution Engineering, Smart Metering, IT, Demand Response, and management
- ECN Common Project Design for testing and comparing GridAgents and ECN-PowerMatcher technologies and algorithms
- Initial Requirements/Use Case Development for SRS
- Configuration of GridAgents software for NREL test site demonstrations
- Installation and integration of GridAgents applications, communications, and inverters at NREL test site
- Initial configuration of GridAgents SmartDashboard for Distribution Engineer and Facility Manager Portals for Alerts and Decision Support
- Initial configuration of GridAgents SmartBuilder for PV agents, DR agents, broker agents, optimization, ISO communications, and integration with SCADA systems, meters, and PV inverters
- On-site surveys and engineering designs completed for Marin Sites
- Initial review of PG&E radial feeders and associated substations in Marin with T&D Engineering

Phase 2 – 2009 – early 2010 Accomplishments

- Completed GridAgents and Network simulations at NREL Test Site
- Completed Requirements Documentation.
- Completed Use Case Documentation – 5 major use cases.
- Revised Test Plans and Software Configuration designs.
- Completed Initial Field Test Monitoring Installations at 5 Marin sites.
- Complete Alpha/Beta Test Software Program Demonstrations and Training for Marin County Office of Sustainability & Facility Managers demonstrating optimized DR based on locational marginal pricing– October 2009.
- Continued GridAgents configuration based on user feedback and expanded monitoring.
- Completed 2nd round Field Tests in Marin with expended decision support and DR curtailment tracking/verification, and renewable production portals – April 2010
- Identified and documented acceptable autoDR actions and expanded renewables management requirements.

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Phase 3 – 2010 Project Objectives and Plans

- Add additional sites with EV Charging Stations, PV, and autoDR capabilities.
- Enhance monitoring and Agent configurations using PQube devices for detailed PV performance, VAR, Power Factor, and Voltage Sag alerts.
- Implement staged autoDR capabilities optimized across multiple buildings with Andover EMS, using Chiller loading and Lighting reductions.
- Integrate wireless and Smart Controllers hosting distributed GridAgents intelligence in multiple buildings without EMS.
- Implement PV Production Alerts based on availability, forecast production, weather conditions. Integrate with autoDR to manage total campus load when renewables are off-line.
- Implement charging strategies based on locational marginal pricing and other facility conditions.
- Expand GridAgents optimization to include Marin renewable portfolio requirements.
- Identify opportunities for expanded applications and potential Phase 4 projects incorporating expanded EV charging, large-scale battery storage, and additional sites under Marin County facilities management.

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More Detail on Site Locations – Marin County

- PG&E's **Las Gallinas substation** (3) 12kV distribution feeders.

- Location 300 ft from the 120 Redwood Building, seen in lower right, which has **2-100 kW PV banks**, sub-metering on 3 sections of building, and Andover EMS system monitoring and control. 900 kW Load

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Marin County Civic Center Campus

- **Civic Center** – highlighted in the red oval on the lower right, is the largest building, with 800kW in total load, some 24 hour operations, and Andover EMS controls.
- **Garage** – highlight by circle in lower left has 75kW in PV, a 150kW backup generator, and some monitoring through the Andover EMS. Also has non-functioning but wired weather station.
- **Vertical Axis Wind Turbine** – 1.5kW with wireless potential shown in small circle top left.
- **Exhibition Hall** – 200kW solar, with no monitoring or link to EMS system. Building is operated by separate county organization, but Marin facilities wants it part of study, as does facility manager for County buildings.

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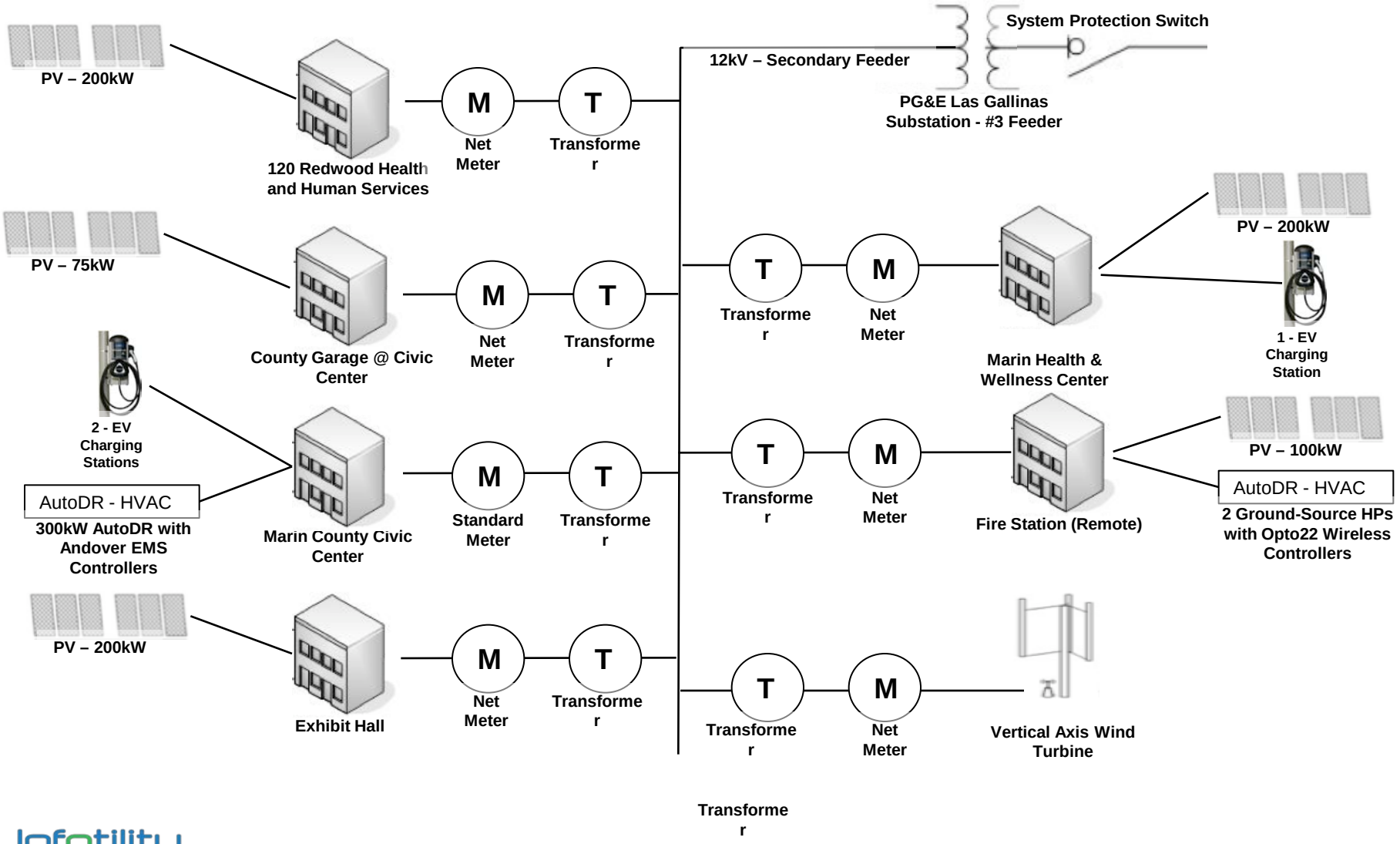
DOE-Marin Smart Grid Field Test – Phase 3



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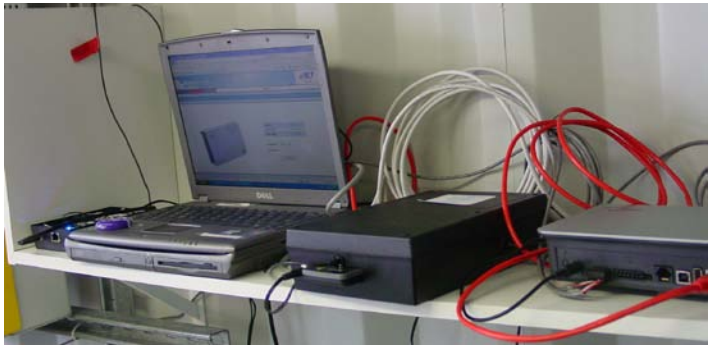
NREL – Equipment for Marin Sites

Sunny Boy inverter

Equipment has been installed at the NREL test facility.



Agent & comm hardware

A laptop, AccessNode, and ControlNode are used to host and communicate with GridAgents

Sunny Island inverter

The installed equipment includes two inverters, one operating as a grid-tied inverter and the other as a stand-alone / grid-tied inverter with storage

Communication with the GridAgents is achieved using a cellular-based WAN, allowing two-way data transfers without compromising the security of the existing NREL network.

WAN antenna

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DOE-Marin – Phase 3 Demonstration Characteristics

- Expanded to 7 medium and large commercial sites owned by Marin County.
  - 5 sites with large scale renewables – 75-200kW per site.
  - 2 sites with 3 Coulomb Technologies EV charging stations.
  - AutoDR capabilities at 4 sites.
    - Integration with Andover EMS systems for HVAC and lighting control at 2 sites.
    - Integration with Opto22 controllers hosting GridAgents modules at 2 sites with HVAC control and wireless remote communications.
  - Integration with CAISO real-time locational marginal pricing at local substation feeder level driving optimization and alerts.
  - Integration with weather services and local weather station for production forecasting and alerts.
  - New optimization algorithms – comparing GridAgents and ECN.
  - Simulated and potentially direct links with PG&E substation data.

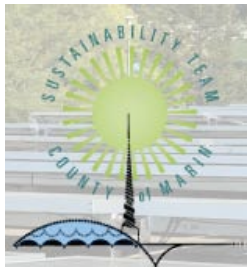
Software Configurations and Use Cases

- Two User Portals
  - Smart Community Energy Manager
  - Renewable Energy Production Portal
- Five Basic Use Cases - Applications
  - Manual and Automated Demand Response based on Local Feeder-level Locational Marginal Pricing and Network conditions
  - Renewables Management, Production Forecasts, Alerts and Optimization.
  - Phase 3 includes EV Charging Coordination based on local conditions.
  - Phase 3 includes the coordination of renewables production, charging, and DR based on Marin energy procurement forecasts.
  - Potential Phase 4 includes - Large-scale Battery Storage.

Smart Community Manager – Site Locations

Multiple Stakeholders and Collaborators

- Marin County – Office of Sustainability
- Marin County – Facilities
- Marin Energy Authority
- CAISO
- Opto22
- Coulomb Technologies
- Power Standards Lab
- NREL
- PG&E
- Bay Area Transportation Committee



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Implementation Issues

- Barriers
  - Communications infrastructure, smart metering, and renewables installations were in early stages of completion requiring creative solutions.
  - Marin facilities provided all installations, electrical, and IT solutions – but had limited availability at times.
- Strategies
  - Phase 3 focus on integrating resources and information for Community Energy.
  - Phase 3 Focus on automated control and decision support.
  - Focus on Decision Support based on local grid conditions for both Marin Facilities/Communities
- Market Impact
  - Marin County sees the power of these applications to manage their diverse portfolio of renewables, as well and manage the local facilities based on local microgrid conditions, as well as under a CCA
  - Early on, PG&E Distribution Engineers see huge value in integrated decision support tool giving them visibility into ranked options for local grid condition response

Technical and Economic Benefits

- Renewable Community Perspective
  - Renewables management, alerts, and tracking
  - Optimization tools for renewables portfolios
  - Community Choice Aggregation – aggregation of mixed renewables
- Utility Perspective
  - Tools for increasing reliability and asset optimization
  - Integration of siloed systems and information
  - Decision support and visibility
  - Flexibility to accommodate changing communications, metering technologies, and smarter devices on the grid
  - Tools for local grid decisions based on local conditions and pricing